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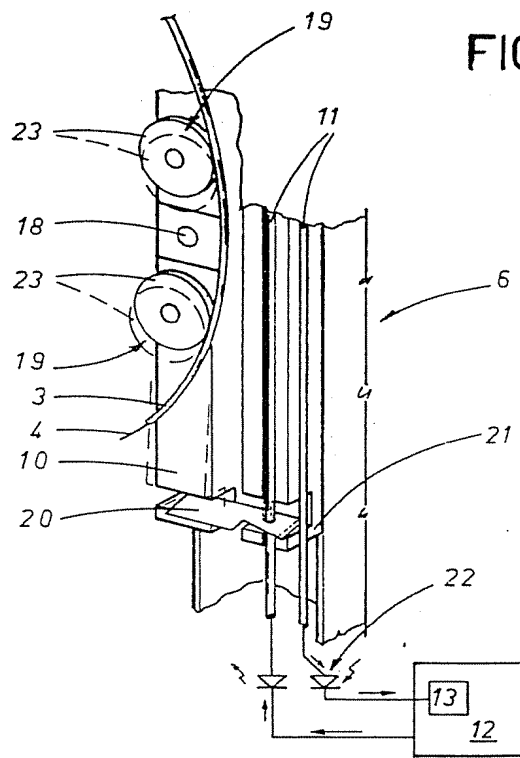
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NL PT SE**(71) Applicant: **POLITECNICA S.a.**  
Via XXVIII Luglio, 212  
SM-47031 Borgo Maggiore(SM)(72) Inventor: Tiziano, Rosignoli  
Viale Casoli, 13  
I-47036 Riccione (FO)(IT)(74) Representative: Lanzoni, Luciano  
c/o BUGNION S.p.A.  
Via Cairoli, 107  
I-47037 Rimini (Forlì) (IT)(54) **An integrated system of perimeter protection and data transmission using optic fibres.**

(57) The invention relates to an integrated system of perimeter protection and data transmission using optic fibres, comprising tracts (2) of fencing realised with tensed wires (3) distributed on levels which are substantially parallel among each other, adjacent levels being distanced less than what is necessary for the passage of a person, the said system comprising, for each tract (2) of fencing, a single wire (3), with at its inside at least a first optic fibre (4), rigidly fixed only at its ends (3a, 3b), so as to be tensed over all of the said tract (2) of fencing with a single operation, and constrained to a single sensor group (6), for the perceiving of any pulling whatsoever on the said single wire (6).

**FIG1****EP 0 603 450 A1**

The invention relates to an integrated system of perimeter protection and data transmission using optic fibres.

Various uses of fibre optic conductors in the field of alarm systems already exist in the prior art. These materials are particularly suitable for a utilisation of this kind, where absolute reliability is required, because of their immunity to natural atmospheric agents, such as rain, snow and wind, as well as to electromagnetic interference.

The principal advantage of the choice of fibre optics lies in the impossibility of short-circuits or of interference in its transmitted signal without the system control unit noticing.

Of particular interest, with reference to the present case, are the prior art applications relative to physical barrier systems using tensed cables.

A first use of fibre optics in alarm systems consisted in its sealing internally to a channel, realised in metal foil and successively covered with adhesive tape.

The metal foil, which could be barbed or not, was then stretched between two support posts. In this way, an alarm signal was received only when the optic fibre was cut, but not when adjacent wires were in some way enlarged so as to permit a person's entrance. To obviate this, wires were made which would break with only minimum variations in their tension. In this way, however, every attempt at unauthorised entrance necessitated the substitution of the forced wire with a consequent increase in the maintenance costs.

Later, optic fibres were used in such a way as to exploit their characteristic of altering the signal, even when only minimum deformations are made and not only when a breakage occurs. This process, called "microbending", consists in arranging the optic fibre according to an arbitrary configuration and making the forcing of the perimeter wire correspond to deformations in the optic fibre itself.

In this way, the presence of the optic fibre in the perimeter fence serves only to signal its cutting, as already happened in the above-mentioned oldest applications: for this reason, the wires used are normal optic fibre cables and have only modest mechanical characteristics.

The deformed optic fibre responsible for the signalling of the attempted forcing of the fence, which might not even contain optic fibres, is found internally to the posts which hold up the fence itself.

Considering a fence of about 100-150 metres in length, a post would be situated about every 2 metres. One out of every two or three of these posts would exhibit internally an optic fibre subject to microbending at the places where the wires pass through the post; the remaining posts having the wire fixed normally and stably.

Unfortunately this is necessary because of the mediocre quality of the wire from the mechanical point of view, necessitating a tensioning of the wire at each post not containing the optic fibre, that is, at most every ten metres.

Consequently, the optic fibre must follow the development of the fence for its entire length, with a significant increase in costs: this solution also requires considerable installation work, because of the quantity of tensing imposed by the quality of the wire used.

Apart from this, the device interpreting the signals indicating handling of the wire, sending and receiving the signal sent from the optic fibre on a certain tract, is normally connected to a control station by means of wires or the selfsame optic fibre. It is obvious that by increasing the length of the fence the quantity of wires necessary to connect the signal interpreting device of the various tract with the control station also increases: furthermore, each further input also requires its own connection.

Consideration must also be given to the fact that a plant made in this way presents other drawbacks, linked to possible false alarms: in the presence of thermal variations caused by atmospheric conditions (for example due to the different degree of exposure to the elements of the various tracts), or due to a progressive deterioration (after bad weather), the wire deforms unevenly, modifying its tension, and this requires a continual adjustment of the tension in the various tracts.

Finally, any use of the optic fibres internally to the fence wires to signal attempts at intrusion by cutting the wire but without alterations to the tension at the posts would appear to be an unjustified expense because of the insufficient use of the quality of these components.

An aim of the present invention, as it is characterised in the claims that follow, is thus that of elimination the above-mentioned drawbacks.

The invention solves the problem by providing a tensed-wire alarm system wherein each tract of fencing comprises a single wire, fixed only at its ends, and a single corresponding sensor group, connected to the control unit of the said tract.

One of the principal advantages offered by the invention consists in its self-balancing with respect to thermal effects, so that false alarms are not induced.

A further advantage consists in the fact that during installation the time and the operations necessary are considerably reduced. The quantity of fibre optic cable present in the sensor posts is also reduced, with a consequent lowering of costs.

The serial connection of the control units of the various tracts allows the plant to be predisposed to exchange information with external acquisition

systems or data processing systems, thus exploiting more adequately the optic fibres present in the fence wires, to which the task of transporting any alarm information from the station control unit is given.

Further characteristics and advantages of the present invention will better emerge from the detailed description that follows, together with the accompanying drawings which represent a preferred but not exclusive embodiment and in which:

- Figure 1 shows a particular of the invention in perspective view, with some parts removed better to evidence others and some parts schematically represented;
- Figure 2 shows a section view of a particular of the invention;
- Figure 3 shows schematically the invention in its entirety;
- Figure 4 shows a part of the fence between contiguous tracts of the invention.

With reference to the drawings, the invention substantially consists of an integrated perimeter protection and fibre optic data transmission system, comprising tracts 2 of fencing made with tensed wires 3 distributed on levels which are substantially parallel among themselves, in a horizontal, vertical and oblique direction. Two adjacent levels are distanced less than is necessary for the passage of a person. The integrated system 1, represented by horizontal wires 3 parallel to the earth, comprises, for each tract 2 of fencing, a single wire 3 with at its inside a first optic fibre 4, rigidly fixed only at its ends 3a, 3b, so as to be tensed along all of the tract 2 with a single operation, acting on one end and keeping the other fixed. In this way it is sufficient to have only one sensor group 6 for each tract of fencing 2 to which the wire 3 is constrained, so that the sensor group 6 can perceive any pulling on the wire 3.

The sensor group 6 is of the analog type and comprises at least one rotatable element 10 and a second optic fibre 11, arranged unilaterally with respect to the wire 3 containing the first optic fibre 4. There will be a proportionate number of rotatable elements 10 for each tract 2 of fencing, normally double the number of levels that the wires 3 describe. The rotatable elements 10, represented in figure 1, will be arranged in the posts which are situated at the ends 2a, 2b of each tract 2 of fencing, correspondingly to the inversions of the arrangement of the wire 3, as is illustrated in figure 4. The two posts of consecutive tracts 2 of fencing, of which only one is equipped with an analog sensor group 6, represented in figure 4, can also be reduced to one post alone of greater size. The rotatable elements 10 and the second optic fibre 11 are mutually connected in such a way that any pulling on the wire 3 determines a rotation of at

least one rotatable element 10, so that the second optic fibre 11 is deformed; the sensor group 6 comprises also a photodiode 22, situated at one end of the second optic fibre 11 so as to read the luminous signal that crosses it, and is associated to continuous monitoring means 12 of the same signal. A sensor group 6 of this kind, particularly useful in the described application, could however be used also in systems not using optic fibres internally, but with good mechanical characteristics in order to be able to stand such a kind of tensing.

Each rotatable element 10 envisages a pivot 18 rotating about a horizontal axis and a portion 19 of curved surface destined to be associated with the said wire 3 with low friction. In the illustrated case the portion 19 of curved surface is equipped with two wheels 23, situated on opposite sides of the rotation pivot 18, in correspondence of which the rotatable element 10 is associated to the wire 3. This specification is particularly useful during the tensing phase of the wire 3, as it reduces the friction. Once the wire 3 is mounted, it is preferably blocked to the rotatable element 10 at the pivot 18 in order to render local deformation of the second optic fibre 11 more evident, which otherwise would distribute over the entire optic fibre 11 length. The connection between rotatable elements 10 and second optic fibre 11 happens through at least one appendage 20, but normally one for each end of the rotatable element 10, to deform the second optic fibre 11, contained inside a vertical guide 21 at a rotation of a rotatable element 10. As can be seen in figure 1, the second optic fibre 11 is arranged on two branches, carrying the optic signal from one to the other of its ends. The branch that runs inside the vertical guide 21 passes also through holes made in the appendages 20 of the rotatable elements 10. When one of these rotates, at least one appendage 20 chokes the second optic fibre 11 in at least one point, modifying the signal carried by it. The photodiode 22 collects a different signal from the one which had been originally carried. The continuous monitoring means 12, downline of the photodiode 22, comprise at least one analog-digital convertor 13, to sample the signal received from the said photodiode 22. The samples are processed by an algorithm which considers very slow variations to be unimportant, neutralising the effects due to drift in the electronic components and to thermal expansion in the mechanical parts.

The rotation pivot 18 is equidistant from the centres of the wheels 23 so as not to induce moments when there are uniformly distributed pulls on the wire 3.

A tensing of this kind is possible because of the special structure of the wire 3, which improves its performance from the mechanical point of view:

it comprises, as can be seen from a transversal section show in figure 2, apart from at least one first optic fibre 4 to transfer an optic signal, at least two coverings 7a and 7b in low-elastic material, one on the left 7b and one on the right 7a, to reduce the torque reaction due to the tension of the wire 3. The external surface is constituted by a plastic sheath 8.

In the illustrated example the two coverings 7a and 7b comprise lines 5 in galvanised carbon steel with a resistance of about 2,000 Newtons per square millimetre and the external sheath 8 is in PVC 80.

In order better to exploit the properties of the optic fibres, while the second optic fibre 11 reads the alarm perturbations, the first optic fibre 4 transports the signal. An analysing unit 9 is associated to each tract 2 of fencing. Since for each tract 2 of fencing there is only one post with a sensor group 6 and the ends 3a, 3b of the wire 3 are fixed to the opposite ends 2a, 2b of the same tract 2 of fencing, the analysing units 9 can be connected in series among themselves: two consecutive analysing units 9 situated at the ends 2a, 2b of a tract 2 of fencing communicate by means of the said single wire 3 with optic fibre 4.

In this way, as is shown in figure 3, a single analysing unit 9 is connected to a central control unit 17, which collects and visualises the data coming from all of the fencing.

Furthermore, each analysing unit 9 is equipped with an interface, which exchanges information with external acquisition systems 16 or external data processing systems 16, so as to transfer from one analysing unit 9 to another, and thus to the central command unit 17, information of various kinds.

To guarantee that portions of the entire integrated system 1 of perimeter protection and fibre optic data transmission do not remain isolated because of any eventual defects in the fibre optic 4 wire 3, the presence of a further wire 14 is envisaged, identical to the preceding, but independent of it, for each tract 2 of fencing, to realise a counter-rotating double ring topology. The signal transferred from one analysing unit 9 to another travels in both directions and if a tract 2 of fencing is handled, the information relative to it continue to arrive at the central command unit 17, thanks to an automatic reconfiguration of the system.

## Claims

1. An integrated system of perimeter protection and data transmission using optic fibres, comprising tracts (2) of fencing realised with wires tensed and distributed on levels which are substantially parallel among themselves, adjacent levels being distanced less than is neces-

sary for the passage of a person, the said system characterised in that it comprises, for each tract (2) of fencing, a single wire (3), with at its inside at least one first optic fibre (4), rigidly fixed only at its ends (3a, 3b), so that the said optic fibre (4) can be tensed over all the said tract (2) of fencing by one operation only, and constrained to a single sensor group (6), aimed at perceiving any pulling whatsoever on the said single wire (3).

2. An integrated system of perimeter protection and data transmission using optic fibres, comprising tracts (2) of fencing realised with tensed wires (3) and distributed on levels which are substantially parallel among themselves, adjacent levels being distanced less than what is necessary for the passage of a person, characterised in that it comprises, for each tract (2) of fencing, a single wire (3) rigidly fixed only at its ends (3a, 3b), so that the said optic fibre (4) can be tensed over all the tract (2) of fencing with a single operation, being constrained to a single sensor group (6), aimed at perceiving any pulling whatsoever on the said single wire (3) and comprising at least one rotatable element (10) and a second optic fibre (11), arranged unilaterally with respect to the said wire (3) containing the first optic fibre (4), mutually connected so that any pulling on the said wire (3) determines a rotation of at least one rotatable element (10), in such a way as to deform the said second optic fibre (11).
3. An integrated system of perimeter protection and data transmission according to claim 1, characterised in that the said wire (3) comprises:
  - at least one first optic fibre (4), to transfer an optic signal;
  - at least two coverings (7a, 7b), in low-elastic material, of which coverings one is on the left (7b), and one is on the right (7a) to reduce torque reaction due to tension on the wire (3);
  - an external sheath (8) in plastic material; so as to optimise the mechanical performance of the said wire (3).
4. An integrated system for perimeter protection and data transmission using optic fibres according to claim 1, of the type wherein to each tract (2) of fencing a unit (9) of analysis of the transmitted signals is associated, characterised in that the said units (9) of analysis are connected serially among themselves, two units (9) of analysis consecutive, situated at the ends (2a, 2b) of a tract (2) of fencing, commu-

communicating by means of the said single wire (3) containing the said first optic fibre (4), the ends (3a, 3b) of the said wire (3) being fixed to the opposite ends (2a, 2b) of the said tract (2) of fencing.

5. An integrated system of perimeter protection and data transmission using optic fibres according to claim 1, characterised in that the said sensor group (6) is of analog type, comprising at least one rotatable element (10) and a second optic fibre (11), arranged unilaterally with respect to the said wire (3) containing the first optic fibre (4), mutually connected in such a way that any pulling on the said wire (3) determines a rotation of at least one rotatable element (10), in such a way as to deform the second optic fibre (11), the said analog sensor group (6) comprising also a photodiode (22), situated at an end of the said second optic fibre (11) so as to read a luminous signal crossing it and being associated to continuous monitoring means (12) of the said signal.
6. An integrated system of perimeter protection and data transmission using optic fibres according to claim 3, characterised in that the said two coverings (7a, 7b) comprise lines (5) made of galvanised carbon steel with a resistance of about 2,000 Newtons per square millimetre.
7. An integrated system of perimeter protection and data transmission using optic fibres according to claim 3, characterised in that the said external sheath (8) is made in PVC 80.
8. An integrated system of perimeter protection and data transmission using optic fibres according to claim 4, characterised in that it envisages a further wire (14), identical to the preceding one, but hanging from it, for each tract (2) of fencing, so as to realise a double counter-rotating ring topology.
9. An integrated system of perimeter protection and data transmission using optic fibres according to claim 4, characterised in that each of the said units (9) of analysis is equipped with an interface for the exchanging of information with external acquisition systems (16) or external data processing systems, so as to transfer from one unit (9) of analysis to another information of various kinds.
10. An integrated system of perimeter protection and data transmission using optic fibres according to claim 4, characterised in that one

alone of the said units (9) of analysis is connected to a control station (17) which collects and visualises the data arriving from each tract (2) of fencing.

11. An integrated system of perimeter protection and data transmission using optic fibres according to claims 2 or 5, characterised in that each rotatable element (10) envisages a pivot (18) of rotation about a horizontal axis and a portion (19) of curved surface, destined to be associated to the said wire (3) with a small degree of friction, each rotatable element (10) further more exhibiting at least one appendage (20) interfering with the said second optic fibre (11), contained inside a vertical guide (21) in such a way as to deform it when a rotation is imparted to the rotatable element (10).
12. An integrated system of perimeter protection and data transmission using optic fibres according to claim 2 or 5, characterised in that the said continuous monitoring means (12) comprise at least an analog-digital converter (13) for the sampling of the signal received from the said photodiode (22).
13. An integrated system of perimeter protection and data transmission using optic fibres according to claim 11, characterised in that the said rotatable element (10) comprises two wheels (23), situated on opposite sides with respect to the said rotation pivot (18), whereas the wire (3) is associated to the rotatable element (10).
14. An integrated system of perimeter protection and data transmission using optic fibres according to claim 13, characterised in that the said rotation pivot (18) is equidistant from the centres of the said wheels (23), so as not to induce moments connected with pullings uniformly distributed on the wire (3).

FIG1

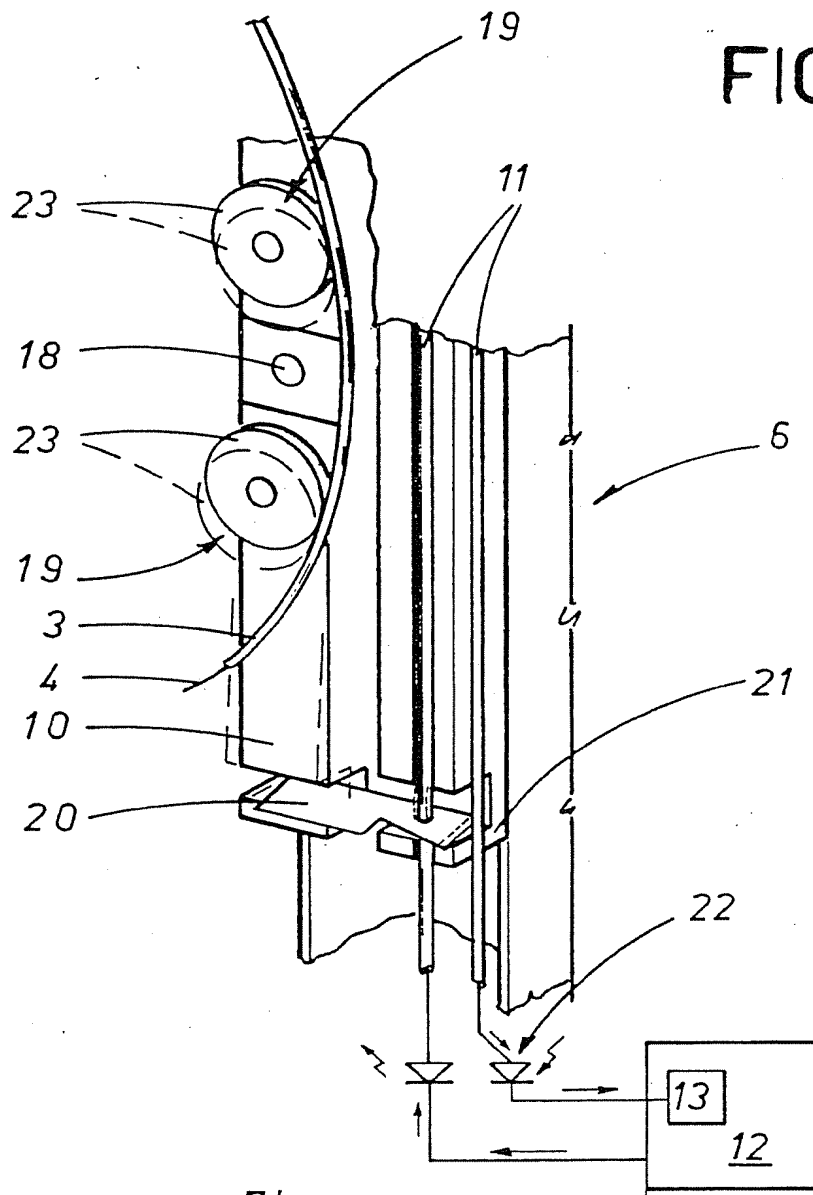


FIG2

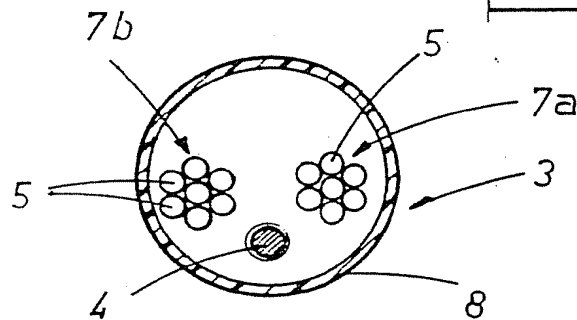


FIG 3

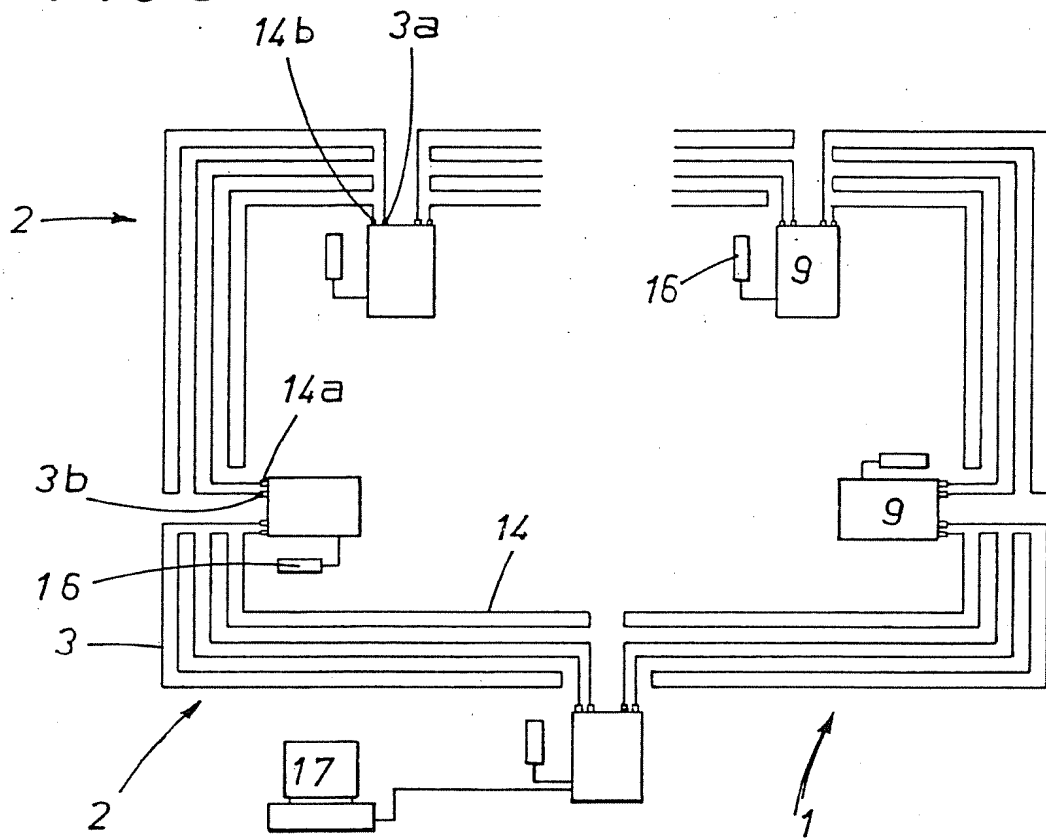
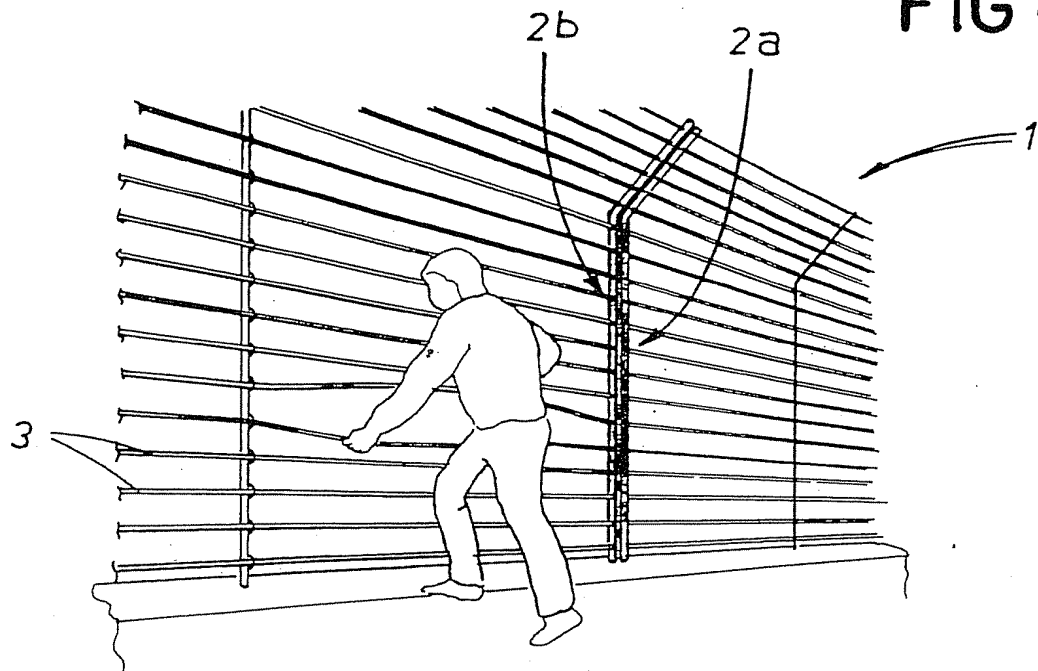


FIG 4





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## EUROPEAN SEARCH REPORT

Application Number

EP 92 83 0642

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	EP-A-0 246 487 (MAGAL SECURITY SYSTEMS) * column 4, line 3 - line 26 * * column 6, line 10 - line 37; figures 1,4A,4B * ---	1-2	G08B13/12
A	EP-A-0 274 040 (SCHUBERT & SALZER) * abstract; figure 1 * ---	1-2	
A	US-A-4 371 869 (R. DAVIDSON) * column 2, line 59 - column 4, line 3; figures 1-4B * ---	1-2	
A	EP-A-0 401 153 (UNITED TECHNOLOGIES CORP.) * column 3, line 46 - column 4, line 22; figures 1-2 * -----	1-2	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			G08B G08C
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 12 MAY 1993	Examiner SGURA S.
<b>CATEGORY OF CITED DOCUMENTS</b> X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure F : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document			

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